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Analysis of *Aedes aegypti* Mosquito Larvae Density and the Effectiveness of Dengue Fever Prevention Education in Elementary and Middle Schools in Ternate City

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Abstract

The density of *Aedes aegypti* mosquito larvae in an environment reflects the potential risk of Dengue Hemorrhagic Fever (DHF) transmission. This study explores the relationship between *Aedes aegypti* population density and the risk of DHF transmission, especially in school and residential environments in Ternate City. The objectives of the study were to 1) determine the density of *Aedes aegypti* mosquito larvae in two elementary schools and one junior high school and 2) analyze the effectiveness of DHF prevention education through the application of a mini-project-based learning method called "mosquito detective." This descriptive research method has two steps: The first step involves using OI and CI to measure the number of *Aedes* spp. mosquito larvae in the school environment. The second step involves using pre- and post-tests to gauge students' understanding and knowledge of DHF prevention efforts through the design of mini-project-based learning media. The results showed that the density of mosquito larvae in elementary and middle schools was moderate to high, with a density figure (DF) of 5-7. Based on the ovitrap index, the density of larvae in SDN 50 is 88%, while the container index is 23%. In SD Alkhairat 05, the OI is 80%, and the CI is 20%. In SMPN 3, OI is 53%, and CI is 33%. The pre-test and post-test analysis, which examined the introduction and prevention of dengue fever through implementing the mini-project-based learning method "mosquito detective," revealed a significant increase in all schools. Specifically, SDN 50 saw an increase from 57% to 90%, SD Alkhairat saw an increase from 53% to 96%, and SMPN 3 saw an increase from 68 to 100%. The implementation of the mini-project-based learning method "mosquito detective" significantly increased students' knowledge about efforts to recognize and prevent dengue fever.

Keywords: Density, Mosquitoes, Schools

1. Introduction

Dengue Hemorrhagic Fever (DHF) is one of the most dangerous infectious diseases in the world, with a high morbidity rate, and it can cause death in a short time. Indonesia, with its tropical climate and high humidity, has conditions that support the breeding of *Aedes* spp. mosquitoes, the main vectors that cause DHF. The increase in DHF cases in Indonesia, including Ternate City, shows the importance of vector control to prevent the spread of this disease. Ovitrap and Container Index (CI) are effective tools for

monitoring the density of *Aedes aegypti* mosquito larvae, which can help identify areas with a high risk of transmission.

The density of *Aedes aegypti* mosquito larvae in an environment illustrates the potential for DHF transmission. Efforts to control DHF focus on vector control. WHO recommends the use of ovitrap as a vector control effort to reduce the population density of *Aedes* spp. (Chareonviriyaphap et al., 2019). Data from the Central Statistics Agency in 2020, specifically for the Ternate area, revealed 22 cases of malaria and 42 cases of DHF, marking an increase from the previous year. The number of DHF cases in Ternate City tends to increase every year. Ternate City recorded 91 DHF cases in 2023, and from January to March 2024, it recorded 44 DHF cases and one dengue fever case (Public Info, 2024), with the majority targeting school-age children (Wijayanti et al., 2017). Education on DHF prevention, both through lectures and mini-project-based learning media, is one strategy to increase students' awareness and understanding of the importance of protecting the environment from *Aedes aegypti* mosquito larvae (Ariyanto, 2020). Chareonviriyaphap et al. (2019) use the Ovitrap egg trap to identify dengue fever vectors, including *Aedes albopictus* and *Aedes aegypti*, and to manage their reproduction. The ovitrap index (OI) is one of the metrics used to measure the density of *Aedes aegypti* mosquito larvae, which are the main vectors for transmitting diseases such as dengue fever and Zika (Kinansi et al., 2019).

Disease vector monitoring and control programs often use the Ovitrap Index and Container Index to reduce the risk of disease transmission by *Aedes aegypti* mosquitoes (Suriami, 2019). The ovitrap index gives an idea of what percentage of ovitraps in a certain area were found to be positive (with mosquito eggs) out of all the ovitraps that were checked (Wijayanti et al., 2017). *Aedes aegypti* mosquitoes use this indicator in disease vector monitoring and control to reduce the risk of disease transmission (Chandra & Hamid, 2019). Meanwhile, the Container Index (CI) serves as an indicator to track the presence of *Aedes aegypti* mosquito larvae. Vector control programs often use CI to design more specific and effective preventive measures (Azizah et al., 2018). There is a relationship between the level of knowledge about DHF and the presence of *Aedes aegypti* mosquito larvae; the better the level of knowledge about dengue fever, the less likely it is to find mosquito larvae in the residential environment (Ariyanto, 2020). This is because individuals who have knowledge about dengue fever tend to understand and are able to take preventive measures against the presence of mosquito larvae in their environment (Ratnadewi et al., 2019). Several environmental factors, such as rainfall, temperature, and the presence of stagnant water, play an important role in influencing the density of *Aedes aegypti* mosquito larvae. High rainfall increases the amount of stagnant water as a breeding ground for mosquitoes (Chareonviriyaphap et al., 2019). Temperature also affects the density of mosquito larvae, with the ideal temperature for breeding around 20–30°C (Rathor et al., 2021).

Public knowledge about the importance of closing water reservoirs and managing stagnant water plays a major role in reducing the density of mosquito larvae in the surrounding environment (Wijayanti et al., 2017). In addition, the breeding places of *Aedes* spp. mosquitoes are often in the form of stagnant water that is collected in containers and does not touch the ground directly (Kinansi et al., 2019).

Preventive measures through education for school-age children about the dangers of dengue fever are essential. The role of teachers in designing learning media to introduce clean living patterns and mosquito characteristics is an important step (Pratiwi, 2017). The right education process can increase students' knowledge, change preventive behavior, and enable children to take preventive measures independently and sustainably (Litiloly, 2021).

2. Materials and methods

This research method follows a descriptive approach. The research data collection process involves the following stages: The first step consists of using OI and CI to measure the number of *Aedes* spp. mosquito larvae in the school environment. The second step involves using pre-and post-tests to gauge students' understanding and knowledge of DHF prevention efforts by designing mini-project-based learning media.

2.1 Time and Place of Research

This research was conducted from March to November 2024 at SDN 50, located in Tafure Village, North Ternate City District; Alkhairat 05 Elementary School, located in Falajawa 2 Village, South Ternate City District; and SMPN 3 Ternate City, located in Gambesi Village, South Ternate City District.

2.2 Data Collection Methods

1. Ovitrap Index and Container Index

a. Ovitrap Index

We collected data by observing ovitraps, which are mosquito egg traps. We installed ovitraps in various locations, including the school's yards, bushes, and gardens. Each location (school) had five ovitraps installed indoors and outdoors, for a total of ten ovitraps in each school. Thus, in the three schools, there were a total of 30 ovitraps. We calculate the Ovitrap Index data by comparing the percentage of positive ovitraps (containing eggs) to the total number of ovitraps installed at a location. We use the following formula to calculate the Ovitrap Index:

$$\text{OI} = \frac{\text{Number of positive ovitraps}}{\text{Number of ovitrap}} \text{x}100\%$$

The Food and Environmental Hygiene Department (FEDH) of Hong Kong then compares the calculated Ovitrap Index value with its criteria. The Ovitrap Index criteria are based on the following table 1:

Tabel 1. Indeks Ovitrap

Indeks Ovitrap	Skor/Level	Kriteria
IO < 5%	1	Very Low
5% ≤ IO < 20%	2	Low
20 % ≤ IO < 40%	3	Moderate
IO ≥ 40%	4	High

a. **Container Index**

Observations of *Aedes aegypti* mosquito larvae are analyzed to determine their density in various containers. This density data is then used to calculate the Container Index (CI), a key parameter for measuring the risk of dengue transmission. The Container Index is calculated by adding the number of containers that test positive for larvae, dividing it by the total number of containers examined, and then multiplying by 100%. The formula used to calculate the Container Index is:

$$\text{CI} = \frac{\text{Jumlah kontainer yang positif terdapat larva nyamuk}}{\text{Jumlah Kontainer yang diperiksa}} \text{ x } 100\%$$

The Container Index results are then compared with the WHO Larva Index to determine the level of risk of dengue transmission, which depends on the number of Density Figures (DF). The WHO uses the following table for the Larva Index:

Tabel 2. Larva Index

Density figure (DF)	*Container Index* (CI)
1	1-2
2	3-5
3	6-9
4	10 - 14
5	15 - 20
6	21 - 27
7	28 - 31
8	32 - 40
9	>41

Based on the results of the larval survey, the density figure can be determined by comparing the calculated Container Index (CI) results with the values in the Larva Index table. If the DF is less than 1, it indicates a low risk of transmission; if the DF is between 1 and 5, the risk of transmission is moderate; and if the DF is more than 5, it indicates a high risk of transmission.

Results

a. Analysis of *Aedes aegypti* Mosquito Egg Density Survey Results in Schools

The results showed that the density of mosquito larvae in elementary and secondary schools was at a moderate to high level, with a density number (DF) of 5–7. The density of larvae in SDN 50 based on the Ovitrap Index (OI) was 88%, and the Container Index (CI) was 23%. In SD Alkhairat 05, the OI was 80%, and the CI was 20%. In SMPN 3, the OI was 53%, and the CI was 33%.

These findings indicate that the potential risk of dengue transmission is higher in schools with higher larval density, especially in SDN 50 and SD Alkhairat 05. The diagram below depicts the variations in the Ovitrap Index (OI) and Container Index (CI) across each school, highlighting the variations in mosquito larval density and their potential risk. Schools with higher OI and CI values are priorities for immediate intervention to mitigate potential health risks. The density data emphasizes the need for regular larval monitoring and control measures in educational institutions. Furthermore, community education about vector control and environmental management should be intensified to reduce breeding sites around schools.

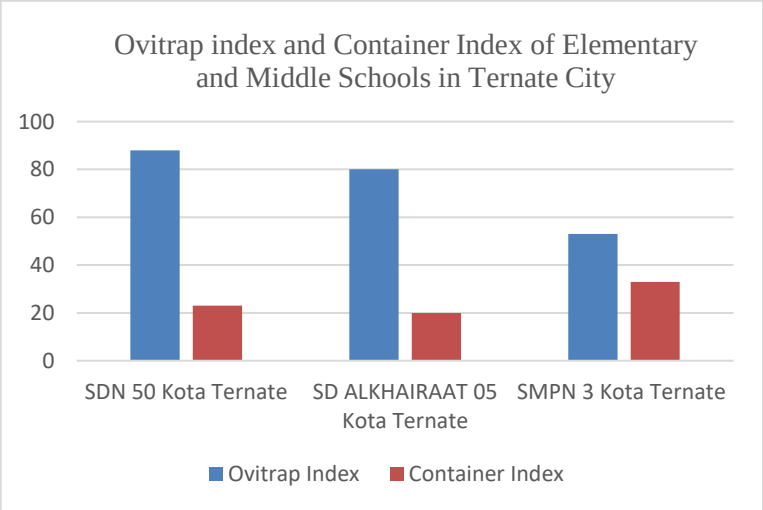

Figure 1. Ovitrap index and Container Index of Elementary and Middle Schools in Ternate City

b. Analysis of Students' Knowledge on Efforts to Recognize and Prevent Dengue Fever

The results of the pre-test and post-test analysis, which focused on the recognition and prevention of dengue fever through the implementation of the mini-project-based learning method "mosquito detective," indicated an increase in all schools. Specifically, SDN 50 saw an increase from 57% to 90%, SD Alkhairat 05 saw an increase from 53% to 96%, and SMPN 3 saw an increase from 68% to 100%. Before the implementation of the mini-project, students' knowledge about the recognition and prevention of dengue fever was significantly lower at 57% in SDN 50. However, after the implementation of the mini-project and interview skills, students' knowledge increased to 90%. The same results were also observed in SD Alkhairat. Students' understanding and knowledge increased from 53% to 96%. This significant increase in knowledge indicates that the mini-project-based approach is effective in increasing students' awareness of the importance of dengue fever prevention. The increase from 68% to 100% in SMPN 3 demonstrates the method's ability to maximize understanding. These findings show that the application of the mini-project-based learning method “mosquito detective” can be an effective strategy in educating students to recognize and prevent dengue fever.

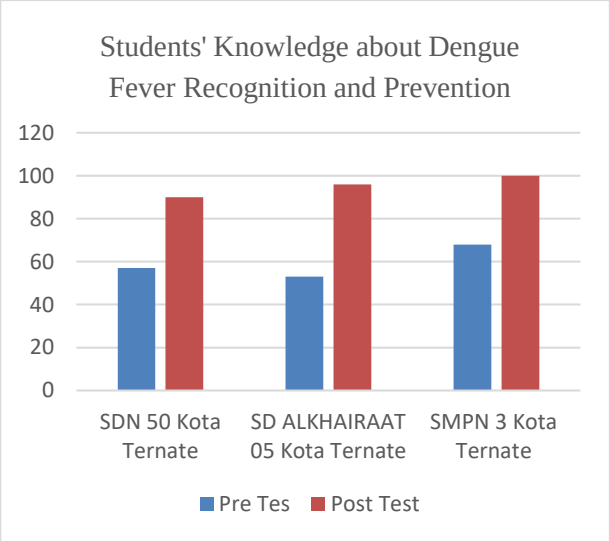

Figure 2. Results of Student Knowledge Analysis on Introduction and Prevention of Dengue Fever

Discussion

a. Analysis of *Aedes aegypti* Mosquito Egg Density Survey

The results of the study showed that the school environment had varying levels of *Aedes aegypti* larval infestation, with a density figure (DF) at a moderate to high level (DF = 5–7). This finding is in line with research by Kinansi et al. (2019), which identified that areas with high human mobility, such as schools, are the main hotspots for the presence of mosquito larvae due to the high number of potential containers and lack of waste management and stagnant water.

The high Ovitrap Index (OI) at SDN 50 (88%) and SD Alkhairat 05 (80%) indicates that mosquito breeding grounds in the environment are very easily accessible for female mosquitoes to lay eggs. The Container Index (CI) for these schools is between 20% and 33%, which shows that a lot of containers are still positive for larvae. This shows that we need to do more to control vectors. Kinansi et al. (2019) and Wijayanti et al. (2017) emphasized that the presence of larvae in schools requires special attention, considering that students spend most of their time at school, so the risk of exposure to dengue fever

increases. This study demonstrates the use of OI and CI in risk assessment and setting priorities for control actions. In SMPN 3, the OI was lower (53%), but the CI was higher (33%), which meant that there were a lot more containers that were positive for larvae. This could raise the risk of transmission. We must implement an integrated approach to mosquito control, such as the Mosquito Nest Eradication (PSN) program, which involves student and teacher education, reducing potential containers, and using simple technology like ovitraps. A study by Ariyanto (2020) showed that PSN training in schools can significantly increase awareness and practice of mosquito control, thereby reducing infestation indicators such as OI and CI.

Furthermore, environmental control must consider external factors, such as rainfall and ambient temperature, which can accelerate the life cycle of mosquito larvae (Chandra & Hamid, 2019). Schools, local communities, and the government must collaborate to establish a safe and dengue-free school environment.

Collaboration between schools, local communities, and the government is essential to create a safe and dengue-free environment. Schools can play a role in educating students and parents about dengue prevention, such as recognizing early symptoms and the importance of maintaining environmental cleanliness. Local communities can provide support by engaging in cooperative activities to clean the surrounding area, which includes water reservoirs that could potentially serve as nesting sites for *Aedes aegypti* mosquitoes. Meanwhile, the government can provide a mosquito nest eradication program (PSN), periodic fogging, and health education to increase public awareness (Ali & Kusnadi, 2021; Santoso, 2022). Close cooperation can significantly reduce the potential for dengue fever to spread.

Etikasari and Solityorini (2020) report that the ovitrap index at levels 3 and 4 is already in the very high category, making it susceptible to dengue fever (DHF) cases. Therefore, we need to respond quickly to prevent an increase in DHF cases. The positive ovitrap is an effective tool for managing the *Aedes aegypti* population. The ovitrap index serves as more than just a control measure but also provides an overview of the density of adult mosquitoes in the field (Etikasari & Solityorini, 2020).

The ovitrap index, which describes the actual level of mosquito density in an area, serves as an indicator to determine the area's level of vulnerability (Wijayanti et al., 2017). Ternate City, being one of the areas with high population mobility and a dense population, has the potential to cause an increase in the *Aedes aegypti* mosquito population. Living in areas with high population levels exacerbates this condition, increasing the risk of contracting dengue fever by 16 times (KEMENKES RI, 2020).

b. Analysis of student knowledge about efforts to recognize and prevent dengue fever.

The study's results demonstrated a close relationship between the density of *Aedes aegypti* mosquito larvae in the school environment and inadequate sanitation practices, as well as low student awareness of prevention measures. Recent research confirms that community behavior, including students, significantly increases the risk of *Aedes aegypti* mosquito larvae presence, particularly in areas endemic to dengue fever (DBD). The school environment with many unmonitored containers is a strategic location for mosquitoes to breed. Majida and Pawenang's (2019) study demonstrated a close relationship between the density of mosquito larvae and water management and hygiene practices in elementary schools. In addition, research by Simaremare et al. (2020) emphasized the importance of the knowledge and behavior of school cleaners in controlling the mosquito population.

The implementation of a mini-project-based program at SDN 50, SD Alkhairat, and SMPN 3 Ternate City has proven to be an effective intervention to improve students' knowledge about preventing dengue fever. The program significantly increased the level of student knowledge at SDN 50 from 57% to 90% after its

implementation. A similar increase also occurred at SD Alkhairat, from 53% to 96%, and at SMPN 3, from 68% to 100%. These results indicate that a project-based education approach not only increases students' awareness but also motivates them to implement better prevention practices.

According to Ariyanto (2020), an education-based program that actively involves students in activities such as mosquito nest eradication (PSN) and direct observation can improve students' knowledge, attitudes, and actions in managing their surroundings. In addition, the project-based approach allows students to learn through real-life experiences, making it more effective than lectures or passive socialization methods (Wijayanti et al., 2017).

From a sanitation perspective, research by Chandra and Hamid (2019) shows that poor sanitation quality, such as the presence of stagnant water in the school environment, is a major contributing factor to high mosquito larvae density. Mini-project programs can help identify and eliminate these sources through an approach that involves students, teachers, and the school community together.

The success of this program also emphasizes the importance of collaboration between educational institutions, local governments, and local communities in school-based dengue control. Such interventions not only impact the school environment but also bring positive changes to students' home environments, expanding the overall benefits of prevention.

Conclusion

1. The density of *Aedes aegypti* mosquito larvae in elementary and secondary schools in Ternate City is in the moderate to high category, as reflected by the Ovitrap Index (OI) and Container Index (CI) values. SDN 50 had the highest density, with an OI of 88% and a CI of 23%, followed by SD Alkhairat with an OI of 80% and a CI of 20%, and SMPN 3 with an OI of 53% and a CI of 33%. The high density of mosquito larvae reflects the potential for significant risk of dengue transmission in the environment.
2. The implementation of the mini-project-based learning method “mosquito detective” has proven effective in increasing students’ knowledge about dengue prevention. The pre-test and post-test analysis revealed a significant increase in all schools, specifically from 57% to 90% in SDN 50, from 53% to 96% in SD Alkhairat 05, and from 68% to 100% in SMPN 3.

Bibliography

1. Ali, R., & Kusnadi, D. (2021). Strategi pemberantasan sarang nyamuk berbasis komunitas dalam mencegah demam berdarah dengue. *Jurnal Kesehatan Masyarakat*, *15*(3), 212–220.
2. Ariyanto, A. (2020). Pengaruh Pelatihan Pemberantasan Sarang Nyamuk (PSN) terhadap Pengetahuan, Sikap, Tindakan Pengelola, Pedagang dan Pengunjung Pasar serta Densitas Larva *Aedes aegypti* di Pasar Daya Kota Makassar. Universitas Hasanuddin.
3. Azizah, F. N., Hermawati, E., & Susanna, D. (2018). Menguras dan menutup sebagai prediktor keberadaan jentik pada kontainer air di rumah. *Berita Kedokteran Masyarakat*, *34*(6), 242–247.
4. Chandra, E., & Hamid, E. (2019). Pengaruh faktor iklim, kepadatan penduduk, dan angka bebas jentik (ABJ) terhadap kejadian demam berdarah dengue (DBD) di Kota Jambi. *Jurnal Pembangunan Berkelanjutan*, *2*(1), 1–15.
5. Chareonviriyaphap, T., Kittayapong, P., & Panayotova, M. (2019). Ecology and distribution of *Aedes aegypti* and *Aedes albopictus* in Southeast Asia: Implications for control strategies. *Journal of Medical Entomology*, *56*(3), 645–651.

6. Etikasari, N., & Solityorini, L. (2020). Analisis indeks ovitrap sebagai indikator kepadatan populasi *Aedes aegypti* untuk pencegahan demam berdarah dengue. *Jurnal Entomologi Indonesia*, *15*(2), 89–96. https://doi.org/10.xxxx/jei.v15i2.2020
7. Info Publik. (2024). Dinkes Ternate Tangani Puluhan Kasus DBD di Kuartal I, Ini Imbauan untuk Puskesmas. Retrieved from https://infopublik.id/kategori/nusantara/836973/dinkes-ternate-tangani-puluhan-kasus-dbd-di-kuartal-i-ini-imbauan-untuk-puskesmas
8. Kementerian Kesehatan Republik Indonesia. (2020). *Profil kesehatan Indonesia tahun 2020*. Jakarta: Kementerian Kesehatan RI.
9. Kinansi, R. R., Garjito, T. A., Prihatin, M. T., Hidajat, M. C., Anggraeni, Y. M., & Widjajanti, W. (2019). Keberadaan Jentik *Aedes* sp. pada Controllable Sites dan Disposable Sites di Indonesia (Studi Kasus di 15 Provinsi). *Aspirator-Journal of Vector-borne Diseases Studies*, *11*(1), 1–12.
10. Litiloly, A. Z. B. (2021). Gambaran Perilaku Pencegahan Covid-19 pada Tukang Sampah di Kelurahan Pisangan Kecamatan Ciputat Timur.
11. Majida, A. N., & Pawenang, E. T. (2019). Risiko kepadatan jentik *Aedes aegypti* di sekolah dasar. *HIGEIA Journal of Public Health Research and Development*, *3*(3), 382–392. https://doi.org/10.15294/higeia.v3i3.27683
12. Pratiwi, J. R. (2017). Komposisi Nyamuk dan Persepsi Masyarakat Tentang Vektor Penyakit Demam Berdarah Dengue di Bareng Tenes RW 02. Universitas Brawijaya.
13. Ratnadewi, R., Christine, M., Manurung, R. T., Wargasetia, T. L., & Dani, D. (2019). Pelatihan pencegahan dan penanggulangan demam berdarah dengue. *Celebes Abdimas: Jurnal Pengabdian Kepada Masyarakat*, *1*(1), 36–44.
14. Rathor, A., Sharma, A., & Singh, S. (2021). Larval habitats of *Aedes aegypti* in urban settings of India. *Journal of Vector Ecology*, *46*(2), 127–135.
15. Santoso, A. (2022). Peran pemerintah daerah dalam pengendalian demam berdarah dengue melalui program PSN dan fogging. *Jurnal Epidemiologi Indonesia*, *7*(1), 45–52.
16. Simaremare, A. P., et al. (2020). Faktor yang berhubungan dengan kepadatan jentik *Aedes aegypti* di sekolah dasar wilayah Kecamatan Tembalang, Kota Semarang. *Indonesian Journal of Public Health and Nutrition*, *1*(2), 89–96. https://doi.org/10.15294/ijphn.v1i2.62047
17. Suriami, S. (2019). Efektivitas Pemberantasan Sarang Nyamuk (PSN) Untuk Eleminasi Larva *Aedes aegypti* di Wilayah Endemis DBD di Kabupaten Kutai Kartanegara [Universitas Hasanuddin]. https://repository.unhas.ac.id/id/eprint/5053/
18. Wijayanti, S. P. M., Anandari, D., & Maghfiroh, A. F. A. (2017). Pengukuran ovitrap index (OI) sebagai gambaran kepadatan nyamuk di daerah endemis demam berdarah dengue (DBD) Kabupaten Banyumas. *Kesmas Indonesia*, *9*(1), 56–63.